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MARGINAL LEAKAGE OF A SOFTENED TEMPORARY RESTORATIONS AS DETERM--ETC(U)
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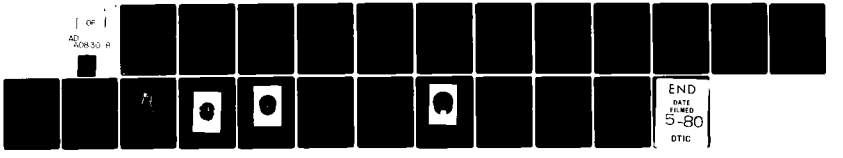

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The ability of Proteus vulgaris to penetrate through IRM and gutta percha was investigated by using an in vitro model system consisting of extracted teeth embedded in acrylic. Cavity preparations in the embedded teeth which were sealed with gutta percha allowed penetration within 48 hours of proteus in 100% of the models, whereas, those sealed with IRM allowed penetration in 36% in 48 hours. The model system was valuable in detecting the penetration of bacteria through temporary restorative materials.

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Marginal leakage of a softened temporary restorations as determined by microorganism penetration

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ABSTRACT

The ability of Proteus vulgaris to penetrate through IRM and gutta percha was investigated by using an in vitro model system consisting of extracted teeth embedded in acrylic. Cavity preparations in the embedded teeth which were sealed with gutta percha allowed penetration within 48 hours of proteus in 100% of the models, whereas, those sealed with IRM allowed penetration in 36% in 48 hours. The model system was valuable in detecting the penetration of bacteria through temporary restorative materials.

Since endodontic therapy may require multiple appointments, a temporary filling material is required to seal the cavity preparation between appointments. This prevents contamination of the canal system by fluids, organic material or bacteria from the oral cavity.

In posterior teeth this material must be particularly strong to resist occlusal forces as well as provide an adequate seal. This seal should also prevent leakage of intracanal medicaments into the oral cavity.

Intermediate Restorative Material*, IRM, basically zinc oxide reinforced with a polymer resin mixed with eugenol, has been recommended rather than unmodified zinc oxide and eugenol to take advantage of the reported higher compressive strength and time saving characteristics.[1]

Previous studies on the ability of IRM to provide an adequate seal are inconclusive.[2,3,4] Massler and Ostrovsky[5] found that of several temporary and permanent restorative materials, unmodified zinc oxide - eugenol and amalgam showed the most effective marginal sealing qualities in vitro using an in vitro dye penetration technique. Paris and associates[6] studied the ability of test organisms (Serratis marcescens and Sarcina lutea) to penetrate cavities filled with various filling materials. Zinc oxide-eugenol did not permit leakage of viable bacteria, but did allow penetration of a 2% aniline dye; however, neither study evaluated IRM. Marosky and associates[2] studied temporary sealing

materials by using calcium chloride ^{45}Ca as a radioactive tracer to produce autoradiographs. They found IRM allowed significantly more leakage of ^{45}Ca than zinc phosphate cement, zinc oxide-eugenol, Cavit# or Temp-Seal%. In contrast, Bramante and others[7] using ^{131}I found IRM making a better seal than Cavit. Many variables such as molecular size, pH, polarity, capillary action and relative coefficients of thermal expansion may influence microleakage by dyes or radioactive labelled elements. Therefore, radioisotope leakage doesn't really indicate how microorganisms will penetrate the temporary seal.[8,9] Penetration by microorganisms rather than dyes or radioactive elements seems to be a more biologically significant approach.

Olmstead, Butler and Gregory[3] observed that IRM was softened more than Cavit or zinc phosphate cement when the set material was placed next to camphorated monochlorophenol (CMCP), formocresol or metacresylacetate. How the surface softening related to overall strength was not evaluated. It is a clinical impression that IRM seems to be maintained in teeth longer than other temporary restoratives. Whether the softening effect caused increased leakage also needed study.

Mortensen, Boucher and Ryge[11] concluded that microleakage basically occurs as a result of bacteria penetrating between restorations and cavity wall preparations. A new model system was devised for this study to test the ability of CMCP - softened IRM to form an adequate seal.

The purpose of this study was to determine if the observed softening of IRM caused by a medicament would allow penetration by a specific highly motile microorganism (Proteus vulgaris.)[12]

METHODS AND MATERIALS

Occlusal access was made into the pulp chambers of 55 extracted, noncarious human molar teeth. The teeth were horizontally sectioned at mid pulp chamber level with a high speed dental bur and water spray. Only the occlusal crown portions with their access openings were retained. The occlusal openings were packed with cotton, inverted and seated in modeling compound on the apex of a glass cone. The remaining enamel or lateral surfaces of the crowns were etched for 2 minutes with a 50% phosphoric acid solution, washed with a water spray and dried.[13] A plastic ring was placed over the mounted tooth in contact with the glass cone which was coated with Vaseline. Acrylic resin was poured into the space created flowing around the etched enamel and separated from the occlusal surface by the modeling compound. (Fig. 1.) After the initial set, the crown and surrounding acrylic were separated from the glass cone. This left the basic model system of an access preparation in an occlusal crown surface setting in an acrylic well. (Fig. 2 and 3.) The tooth enamel-acrylic margins were sealed with fingernail polish to further insure an effective barrier to the microorganisms.

All acrylic tooth models were autoclaved. Utilizing an aseptic technique, IRM was mixed according to manufacturer's instructions,

condensed into the occlusal preparation and allowed to set in contact with 20 microliters of 35% CMCP on a #0 cotton pellet.[3] (Fig. 4.) Control models of IRM, Cavit and gutta percha[+] were prepared in the same manner but allowed to set in contact with 20 microliters of sterile saline. The cotton pellets with medicament or saline were placed in depressions in acrylic blocks (30 x 25 x 24 mm) setting in 4 oz medicament jar, both of which had been autoclaved. Thus, the model systems were set on top of the acrylic blocks with the temporary restoration on top of the medicament and the lids closed. (Fig. 4.) After setting 24 hours, the model systems and acrylic blocks were removed from the medicament jars. Using aseptic techniques the thickness of the temporary material was measured using a modified Boley gauge. Two sterile cotton rolls and 30 ml of sterile trypticase soy broth were placed in each jar. The model systems were replaced into the medicament jars so the base with its exposed dentin, enamel, and temporary were bathed in the broth. A rubber stopper with a hole was seated in the funnel opening of each model system and the lid again closed. (Fig. 5.) The medicament jars and contents were then incubated for 24 hours at 37°C and cultures taken to verify initial sterility.

At this time, a fresh aliquot of 2.5 ml of Proteus vulgaris was injected through the hole in the rubber stopper to bathe the occlusal enamel and surface of the temporary filling material. A sterile cotton pellet was placed in the rubber stopper hole.

The media was replenished at days 5, 9, 14, and 19. Each time the bacterial culture was replenished the old culture was plated to insure continued viability of the microorganism. To detect leakage of the temporaries, culture samples were taken at 1, 2, 3, 4, 5, 13, and 21 days from the trypticase soy broth in which the model systems sat and streaked on blood agar plates. Positive growths were identified according to standard methods in Bergey's Manual of Determinative Bacteriology.

Two models with the teeth but without occlusal preparations and two models with only acrylic were also prepared and tested to check the basic system's effectiveness.

RESULTS

After 48 hours, 6 of 23 (26%) models of IRM next to CMCP, allowed passage of Proteus vulgaris while 12 of 23 (52.2%) allowed passage after 13 days. (Table I). Six of 23 (26.1%) remained negative at 21 days.

The mean thickness of the IRM was 1.78 milimeters. The mean thickness of those that allowed passage within 48 hours was 1.60 mm. The mean thickness of those that denied passage of the microorganism was 1.85 mm.

Of the six models with gutta percha, all allowed Proteus vulgaris to penetrate within 48 hours. (Table I). A chi square analysis[14] indicated that the null hypothesis equating leakage of the IRM with the gutta percha after 48 hours can be rejected at the .01 confidence level. (Table II). This difference in

sealing ability was therefore considered significant. After 13 days the difference in leakage between gutta percha and IRM was still statistically significant at the .05 confidence level. (Table III).

The results for the controls of Cavit and IRM which set up in contact with saline were not statistically significant due to the limited numbers of specimens. However, it is of interest to note that of the 6 Cavits, mean thickness of 2.99 mm, 4 were contaminated by 82 hours and all 6 by 13 days. Of the 5 IRM next to saline models with a mean thickness of 2.0 mm, only 1 was contaminated by 72 hours, but all 5 were by 13 days. (Table I).

The intact crowns encased in acrylic and the acrylic blocks without any teeth remained negative throughout.

DISCUSSION

If microorganisms can gain access to the pulp chamber of teeth undergoing root canal therapy, it may jeopardize the favorable outcome of the treatment. Temporary sealing materials which prevent the ingress of saliva and microorganisms should therefore be used. Various means such as dyes, radioisotopes and microorganisms have been used to test the penetrability of numerous materials. Microorganisms are of chief concern, and this study was designed to determine the sealing ability of IRM, a frequently used temporary seal. *Proteus vulgaris* was chosen not because it is found in the oral cavity, but because it is one of the most penetrating and motile organisms available.[12]

The IRM which had been softened by contact with CMCP compared with IRM in contact with sterile saline is only suggestive, but since all five leaked within 5 days a preliminary indication is that the CMCP did not decrease the seal of the IRM. It was also suggestive that perhaps Cavit seals no better than IRM since five of the six Cavit fills leaked within 5 days and all six by 13 days. This seems to confirm two other recent articles which seem to question the sealing ability of Cavit.[15,16]

IRM in contact with CMCP provided a seal in 74% of the models after 48 hours, in 47.8% after 13 days and 24% after 21 days. The authors feel this information is more pertinent than leakage of radioisotopes or dyes which may relate more to percolation of small molecules and capillary action than to leakage of microorganisms of their products.

The thickness of the IRM in this study was not significant although a larger sample in each category with greater thickness variation should be done.

The model system utilized did not allow passage of the microorganisms when used with an intact tooth embedded in acrylic. This system can be used to study other materials and their ability to seal out microorganisms.

The seal of the Cavit and IRM setting next to saline, while too few here to be of significance, indicate a need for further study.

SUMMARY AND CONCLUSIONS

Penetration of microorganisms along the IRM or gutta percha interface with enamel or dentin was studied using Proteus vulgaris as the test organism.

Seventy-four percent of the tooth-acrylic models sealed with IRM as a mean thickness of 1.78 mm did not allow passage of Proteus vulgaris after 48 hours. However, 52.2% of the models were penetrated after 13 days, and 73.9% after 21 days.

All models sealed by Cavit and IRM which set in contact with saline allowed leakage within 13 days.

The gutta percha at a mean thickness of 2.9 mm allowed the microorganisms to penetrate along the dentin and gutta percha interface in 100% of the models after 48 hours.

The model system may be utilized to study the sealing ability of various materials to microorganism penetration.

Further studies are indicated using more models of each group studied.

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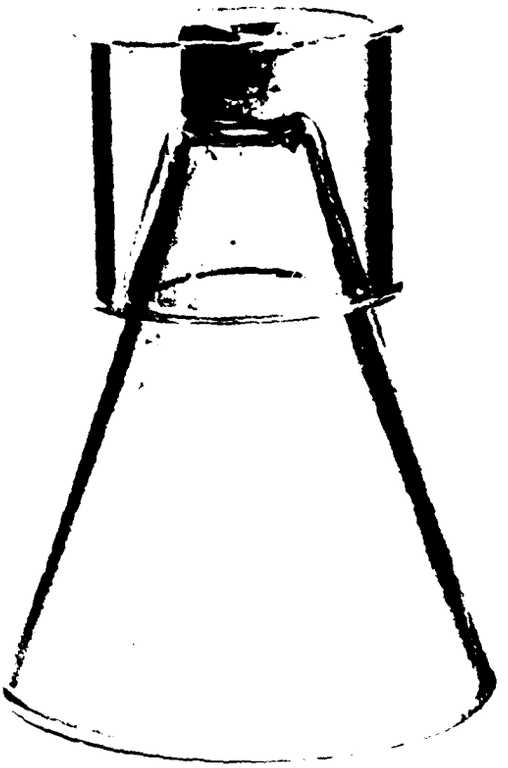

Figure 1. Plastic ring surrounding the mounted tooth ready to be filled with acrylic resin.

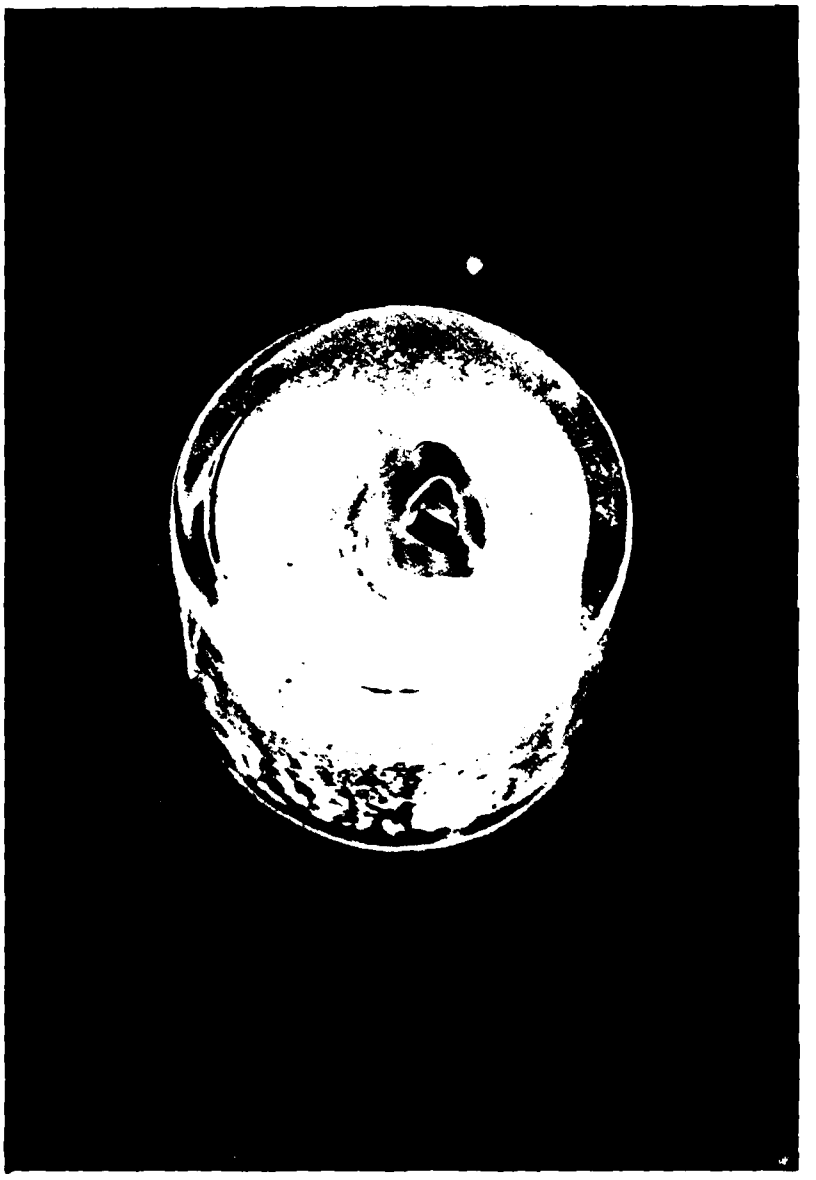

Figure 2. Tooth-acrylic model system from a radicular view.

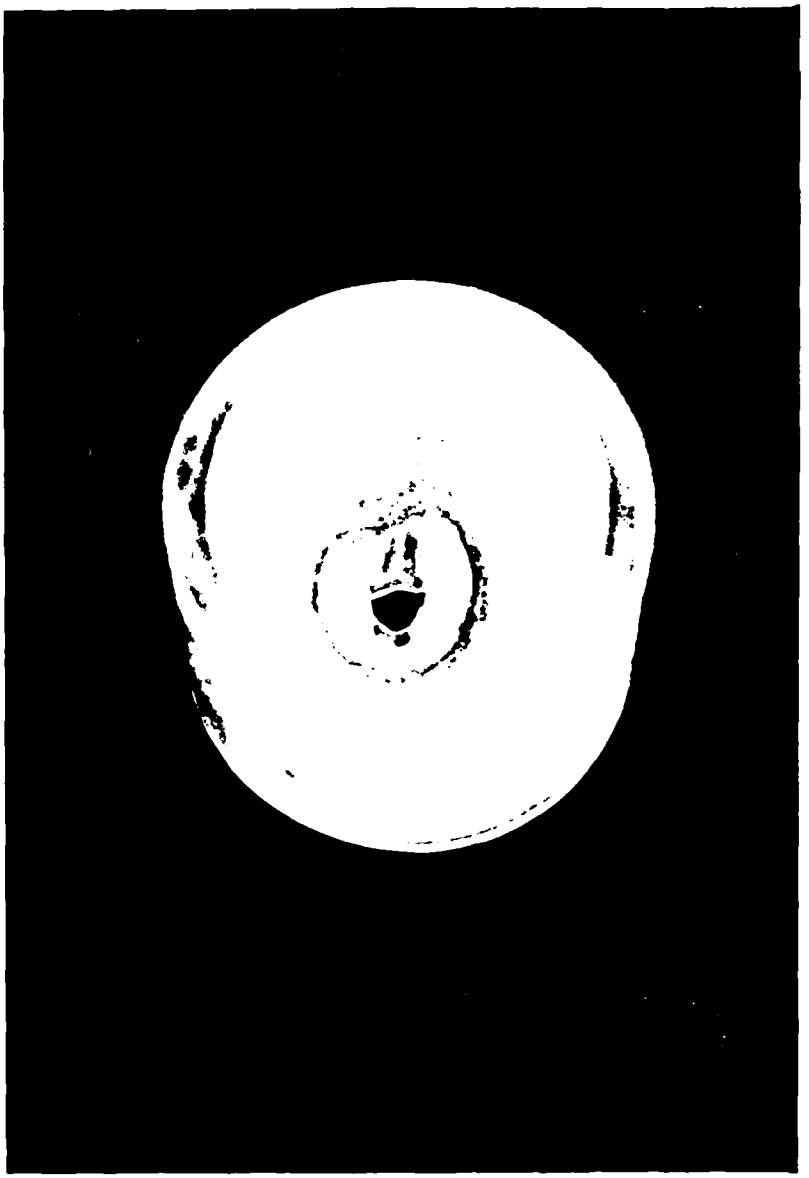

Figure 3. Tooth-acrylic model system from an occlusal view.

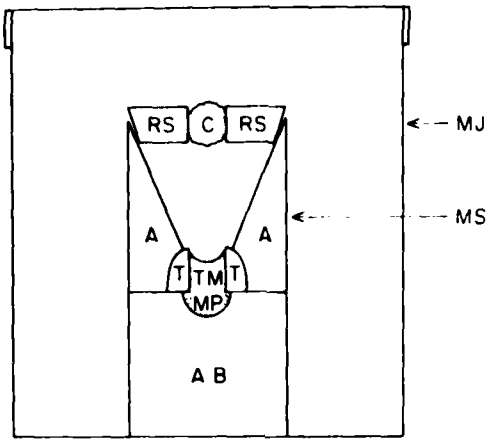

Fig 4 Model System (MS) during 24 hrs following placement of temporary material (TM) into access opening in tooth (t) which is encased in acrylic with rubber stopper (RS) with opening filled with cotton (c) The tempoory is setting next to medicated pellet (MP) in depression in acrylic block (AB) Both (MS) and (AB) are in 4 oz medicament jar (MJ)

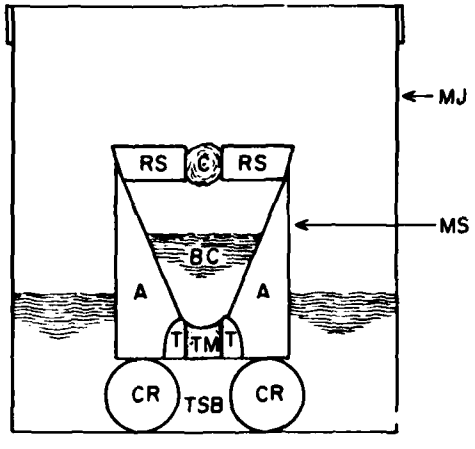

Fig. 5-a Model System (MS) with tooth (T) and temporary material (TM) with rubber stopper (RS) and cotton (C) in its opening, holding bacterial culture (BC). The (MS) is sitting on two cotton rolls (CR) in Trypticase Soy Broth (TSB) all in 4 oz medicament jar (MJ).

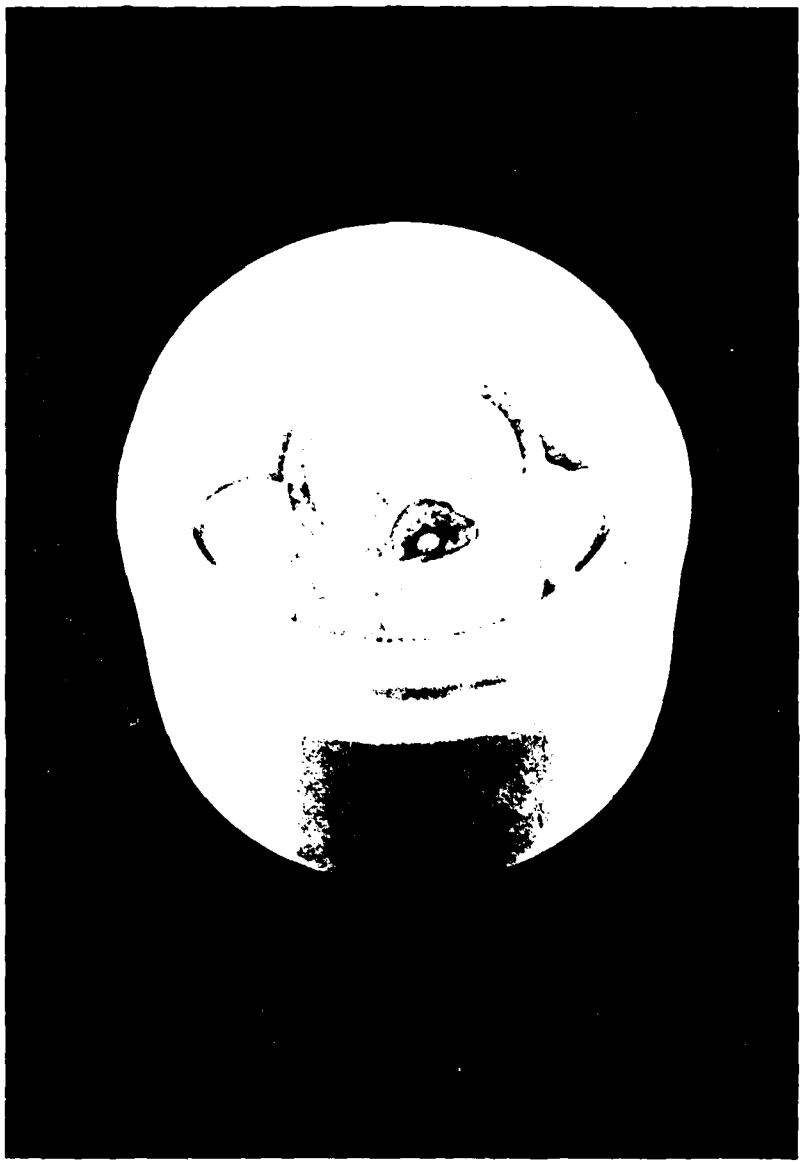

Figure 5-b. Tooth-acrylic model in 4 ounce medicament jar prior to incubation.

TABLE I: Number and percentage of models leaking at each time period.

		Total Cases	1 day	2 days	3 days	4 days	5 days	13 days	21 days
IRM + CMCP	No.	23	3	6	7	7	8	12	17
	%	100	13.0	26.1	30.4	30.4	34.8	52.2	73.9
IRM + Saline	No.	5	0	0	1	3	5		
	%	100	0	0	20	60	100	-	-
Cavit + Saline	No.	6	2	3	4	4	5	6	-
	%	100	33.3	50	66.7	66.7	83.3	100	
Gutta Percha + Saline	No.	6	4	6					
	%	100	66.7	100	-	-	-	-	-

Table II: Number of models leaking or showing no leakage of gutta percha and IRM next to CMCP at two days.

	Models leaking	Models not leaking	Total
IRM + CMCP	6	17	23
gutta percha	6	0	6
totals	12	17	29

$df = 1, x^2 = 11.32, p < .01$

Table III: Number of models leaking or showing no leakage of gutta percha and IRM next to CMCP at thirteen days.

	Models leaking	Models not leaking	Total
IRM + CMCP	12	11	23
gutta percha	6	0	6
totals	18	11	29

$df = 1, x^2 = 4.7, p < .05$